3023

Ontario

Ministry of the
Environment

REFERENCE DOCUMENT

MODEL
MICROBIAL CONTAMINATION CONTROL PLAN
FOR
MUNICIPAL GROUNDWATER SUPPLY WELLS
UNDER DIRECT INFLUENCE OF SURFACE WATER
WITH EFFECTIVE *IN SITU* FILTRATION

Date: January 2004

REFERENCE DOCUMENT

Model Microbial Contamination Control Plan
for
Municipal Groundwater Supply Wells under Direct Influence of Surface Water with Effective *in situ* Filtration

January 2004

1. PURPOSE

This Reference Document is a companion to the Ministry's Guidance Document entitled "Development of a Microbial Contamination Control Plan for Municipal Groundwater Supply Wells under Direct Influence of Surface Water with Effective *In-Situ* Filtration" ("Guidance Document") and should be read in conjunction with that document.

This Reference Document is intended to provide additional information for municipalities developing Microbial Contamination Control Plans in accordance with the Guidance Document noted above. Not all information included in this document may be applicable to a particular situation, and certain requirements identified in the Guidance Document are not addressed in this document (e.g., implementation schedule or submission to MOE). This document is not a guide against which the Microbial Contamination Control Plans submitted to the Ministry for approval would be evaluated. Ministry evaluations of microbial contamination control plans will be made based on the Guidance Document.

2. AREA GEOLOGY AND HYDRGEOLOGY

The Microbial Contamination Control Plan should provide an overview of local hydrogeological conditions and water supply systems. The Plan would typically include a summary of the hydrogeological descriptions and assessments included in the Groundwater Under the Direct Influence of Surface Water Assessment reports and studies including:

i) Quaternary and Bedrock Geology: Show key topographic/geological features describing overburden thickness, composition, grain size distribution and sedimentary textures.

ii) Local hydrogeology: Define hydrogeologic features (aquitards and confined, unconfined and semi-confined aquifers) including details of their depth, thickness, lateral continuity, porosity, vertical/horizontal hydraulic gradients, hydraulic conductivity, transmissivity, storativity/specific storage and the location/nature of aquifer recharge supplying the well. The report must include the following descriptions of the study area: (1) a detailed map that is drawn to scale, (2) hydrogeological cross-section with geology, borehole locations and water level measurements and (3) borehole logs with accurate geological descriptions.

3. *IN SITU* FILTRATION ASSESSMENT

3.1 Particle Counts:

- Clearly demonstrate that raw water consistently contains significantly less than 100 particles per ml in the size range 10 microns and greater in size.

- Confirm that particle counts remain constantly low during storm, season or other regular environmental changes. This is required to ensure that embedded microbes are not shielded from effective UV or chlorine disinfection.

3.2 Raw Water Microbial Content:

- Confirm that the raw water does not contain high microbial loadings that could overwhelm disinfection processes.

The Microbial Contamination Control Plan must, therefore, address both particle counts and microbial loadings.

4. DELINEATION OF MICROBIAL RISK MANAGEMENT ZONES

4.1 Delineation of Time of Travel Zones

Time of travel zones must be delineated for each municipal well and well-field to which the requirement applies. The delineation must be completed in accordance with the Ministry document ***"Protocol for Delineation of Wellhead Protection Areas For Municipal Groundwater Supply Wells under Direct Influence of Surface Water"*** ("Delineation Protocol").

4.2 Groundwater Intrinsic Susceptibility Mapping

General Procedures – The hydrogeologist must develop a conceptual model of the hydrogeologic system for which the intrinsic susceptibility mapping is to be created. Developing a hydrogeologic conceptual model will require the expertise of an experienced hydrogeologist. The hydrogeologist can then determine the critical factors that must be assessed and integrated into the susceptibility assessment.

In the context of the data available from the MOE Water Well Information System (WWIS), groundwater intrinsic susceptibility can be inferred from the well geology, water table position, vertical gradients, water bearing zones and, where applicable, well screen location. Proximity to surface water should be noted.

The Ministry recognizes that elements of the maps are the product of considerable interpretation and consultants are encouraged to apply local expertise to improve the quality of the mapping product. Local knowledge of groundwater flow systems, pump tests, geochemistry, soils, topography and other factors could have important effects on vulnerability assessments when taken into account. For the local context the consultant must apply knowledge of local hydrogeologic/geologic conditions, factors and uncertainties in existing databases to enable the best decisions to be made on vulnerability.

Intrinsic Susceptibility Index (ISI) mapping must be conducted to 500 m outside 2 year time of travel (TOT) zone unless total extent of aquifer is less.

References – The International Association of Hydrogeologists publication "Guidebook on Mapping Groundwater Vulnerability" (1994, edited by Jaroslav Vrba and Alexander Zaporozec) is recommended as useful reference to further understand founding concepts of aquifer vulnerability mapping, and provide guidance on the use and interpretation of the data types available.

4.2.1 **Step 1 - Data Preparation:** Develop a conceptual model of local hydrogeological conditions using data from boreholes and well logs etc. The Geological Survey of Canada has developed rules for improving the geological descriptions in the MOE Well Log Database which are presented in **Appendix A - GSC Geomaterial Protocol.** Geochemistry and isotope data may be required where there are limited or poor quality data, particularly within the 50-day zone. The conceptual model should be calibrated using hydraulic data to confirm the integrity of confining layers etc.

4.2.2 **Step 2 - Determining Depth to Water Bearing Zone:** Depth to upper contributing water bearing zone or the top of the bedrock, whichever is shallower, is used in the preparation of the GwIS map. The consultant is required to assess the local hydrogeological regime and develop a rationale for selecting relevant data points for the generation of the mapped aquifer surface.

For confined aquifers, it is reasonable to assume that contaminants from the surface must migrate through the confining layer and reach the aquifer to cause potential impact. Therefore, the depth should be calculated from ground surface to the top of the first significant aquifer. For unconfined aquifers, it is reasonable to assume that contaminants from the surface must only migrate to the water table to cause potential impact. Therefore, the depth is calculated from ground surface to the water table.

4.2.3 **Step 3 - Assigning Material Permeability:** For each stratigraphic layer, a K-Factor is estimated and is multiplied by the thickness of that layer (see **Appendix B - Generic Representative Permeability Table**). The K-Factor is a dimensionless, relative number that can be loosely related to the exponent of the vertical hydraulic conductivity in m/s.

4.2.4 **Step 4 - Intrinsic Susceptibility Index (ISI) Calculation:** The ISI is calculated by summing the product of the thickness of each vertical geological unit (in metres) and corresponding K-Factors. The calculation is performed from surface to a lower limit defined by the upper water bearing zone contributing to the well or the top of the bedrock surface (whichever is shallower).

4.2.5 **Step 5: Categorizing Intrinsic Susceptibility Index (ISI) Values:** The summed value of the K-Factors is then used to classify areas into categories: High (<30), Medium (30 to 80), or Low (>80) intrinsic susceptibility to contamination. The classification thresholds defining the limits of these categories may be adjusted to reflect local hydrogeological resources and functions. The rationale for adjusting the threshold must be clearly described and justified.

4.3 Microbial Risk Management Zone Mapping

A matrix system which integrates the aquifer Intrinsic Susceptibility Index and the Time of Travel zones has been developed to assist in the development of Microbial Risk Management Ratings for the immediate area surrounding each municipal well. The intent of this mapping exercise is to provide a framework for the development of the required microbial contamination control plan.

Microbial Risk Management Rating

Saturated Zone Time of Travel	Intrinsic Susceptibility Index		
	<30	30 to 80	>80
0 - 50 days *	HIGH	HIGH	HIGH/MOD*
50 days - 2 years	HIGH	MODERATE	LOW
>2 years **	MODERATE	LOW	LOW

* NOTE: Where this zone is not well defined by a calibrated hydrogeological model, a distance of 100 metres for overburden flow systems and 500 metres for bedrock flow systems should be used.

** NOTE: Land use activities beyond the 2-year boundary need to be considered where it is necessary to allow for increased future pumping rates, where there is significant uncertainty regarding boundary placement or where there are high risk activities that may be impacted directly or through surface water flows.

Three risk ratings (High, Moderate and Low) have been defined below:

High Risk: In the areas defined as high risk, microbial contaminants can rapidly infiltrate into the water supply aquifer and begin migrating toward the well(s). Ideally, no **significant potential sources of microbial contaminants** should be permitted in High Risk areas. Where it is not practical to eliminate existing potential significant contaminant sources in this area, stringent measures to manage the risk posed by these sources must be developed and timely, effective contingency plans established.

** To ensure adequate protection in the immediate vicinity of the well(s), it is recommended that the 50 day time of travel zone be defined as a high risk area regardless of the Intrinsic Susceptibility Index (ISI) rating. Exceptions which result in a Moderate Risk rating may be made only in cases where:*

1) the ISI significantly exceeds 80, AND
2) it can be clearly demonstrated that contaminant short-circuiting pathways are not present in the confining layer, AND
3) policies are put in place to prohibit the creation of such pathways within the 50-day time of travel zone.

Moderate Risk: The moderate risk areas require the development of a plan to manage and monitor risks posed to the well supply by potential microbial contaminant sources.

Low Risk: Low Risk areas are those in which minimal controls are necessary to ensure effective protection of the well from microbial contamination.

5. POTENTIAL MICROBIAL CONTAMINATION MANAGEMENT

5.1 Contents of the inventory of contamination sources

Information on each of the identified existing and potential sources of contamination should be compiled in a list including:

a) description of the contamination source
   - source name (if applicable), and name of owner/operator
   - indication if it is an existing or potential source
   - type of the source (see Table 5.2)
   - approximate areal size of the source
   - permanent intermittent

b) location of the source
   - address (if applicable)
   - geo-reference information based on NAD83 (North American Datum 1983). Field-based GPS coordinates are mandatory for major potential contaminant sources in high risk areas; desktop analysis may be sufficient in low risk areas.
   - approximate saturated horizontal TOT to the well/well field
   - linear distance to the well/well field
   - current municipal land use zoning and land use designation for the location
   - current land use
   - source risk rank or category (see below)

In addition to the inventory list, all identified existing and potential sources of microbial contamination must be accurately plotted and identified (existing/potential, name and type) on a copy of the to-scale TOT delineation map prepared in accordance with the Delineation Protocol. This copy of the TOT delineation map must also identify the current municipal zoning and land use designations.

5.2 Risk Ranking/Categorization of the Contaminant Sources

Any identified source of microbial contamination within the delineated time of travel zones can pose a risk of contamination and possible loss of the water supply. Due to limited resources, however, it may be necessary for the municipality to focus efforts on the sources which pose the most significant risks.

In order to establish priorities for the plan of implementation of microbial contamination control measures, it is necessary to evaluate the relative degree of risk that the individual contamination sources identified in the inventory pose to the water supply.

Where a potential contamination source has been identified, and the individual business owners and agricultural operators are using established BMPs for groundwater protection , the contamination source will not generally need any additional attention at the present time.

Similarly, a potential contamination source may be considered a low hazard source, and not require any immediate remedial action, where the owner of the facility in question, under conditions of its approval/permit, was required to install a network of monitoring wells upgradient and downgradient from its site, and it has been determined that the monitoring program and remedial action plan in place are adequate.

As noted above, the risk rank or category of <u>each</u> source must be noted in the source inventory list. In a preamble to the source inventory list, the criteria used in the risk ranking must be identified, including reasons for the choice of the criteria.

5.3 Microbial Contamination Control Measures

Although some of the microbial contamination management tools identified here refer to regulatory programs, it is generally accepted that groundwater protection within specific time of travel zones of the microbial contamination control areas can be accomplished most effectively and at the least cost by developing partnerships with local business, industry and

the agricultural community, and focussing on educational/training and pollution prevention or best management practices concepts.

Since groundwater can be affected by a wide variety of human activities and sources, a comprehensive groundwater protection program would need to incorporate various types of measures. The various microbial contamination control measures may be categorized into three general areas:

- pollution prevention/best management practices (BMPs),
- regulatory permitting/environmental assessment, and
- land use controls or restrictions.

5.3.1 General microbial contamination control measures

Components of the plan should include, but not necessarily be limited to:

1) identification of the potential risks,
2) recommendations to reduce and manage the risk of contaminant release to the environment, and
3) recommendations for control of new development and specific activities within the area

Microbial contamination control measures that may apply to all activities that may result in microbial contamination of groundwater include the following tools:

- Public Education;
- Installation of Signs;
- Water Conservation;
- Public/Private Partnerships;
- Zoning By-laws;
- Groundwater Monitoring;
- Property Purchases;
- Septic System Upgrades;
- Potential Source Restrictions,
- Certificates of Approval
- Farm Management Plans (Nutrient Management Act)

The tools listed above are applicable to all types of potential contamination (not only microbial contamination). However, the list does not include tools that are otherwise very useful in preventing groundwater contamination, but are not applicable to sources of microbial contamination (e.g.,hazardous waste collection programs, spill response plans, or special chemical use and transportation prohibition). Table 5-1 provides a brief discussion of the contamination control tools that may be relevant to potential microbial contamination.

Table 5-1: General Management Tools Available for Microbial Protection

1. **Public Education/Notification:**
This option is highly recommended for implementation within the entire microbial contamination control area. Every effort should be made to contact all property owners within the microbial contamination control area so they are aware of the need for protection measures. One of the tools in accomplishing this may be organizing one or more workshops where information would be available and presentations would be made to inform local residents of the connection between drinking water quality and activities on the land surface.
The focus of such an educational effort should include:
- basic information about groundwater and the relationship between surface activities and groundwater quality,
- familiarity with the location of the protected area,
- basic information on sources of contamination, and
- effective strategies for safe management of all potential contaminants.

2. **Sign Installation:**
Information signs should be placed adjacent to all roadways entering the microbial contamination control area. The signs should include the name of the water system or jurisdiction along with a phone number where callers can obtain more information.

3. **Water Conservation Program:**
Implementing water conservation measures in your community can significantly benefit microbial contamination control efforts. Reductions in pumping rates may reduce flow rates within the aquifer and the associated risk of transporting any contamination within the aquifer. Conserving water may also help reduce the need for additional water sources in the near future. Water conservation can be accomplished through steps such as distribution of flow control devices, retrofitting high-flow toilets and washing machines.

4. **Public/Private Partnerships:**
It is highly recommended that the public authority having jurisdiction over the water supply system seek partnerships with the private business, commercial, and industrial communities within the microbial contamination control area. These public/private partnerships can involve setting up a process for collaboration and finding common goals, such as maintaining low cost clean drinking water, encouraging best management practice applications, and continued economic prosperity in the region. Mutual benefits may include maximizing pollution prevention implementation in the community, public recognition of "green businesses", etc.

5. **Zoning and Other By-laws:**
The existing municipal zoning within the microbial contamination control area may be reviewed, and were feasible, the zoning could be adjusted to restrict certain types of developments and land uses. By-laws may also be introduced to restrict certain activities within the area or impose special permitting requirements for new building applicants or impose requirements for implementation of measures that minimize the risk of contaminating the public water supply.

6. **Groundwater Monitoring Program:**
Collecting data from existing monitoring and water supply wells and installation of dedicated monitoring may help your community detect any contaminants that could threaten the water supply in the near future. This is especially useful in locations down-gradient from any high risk contamination sources in the microbial contamination control area.

7. **Property Purchase/Donation Program:** Community ownership of as much as possible of the land within the microbial contamination control area obviously provides some of the best assurances of long-term protection of the public water supply. Protection could be provided by ownership accomplished through methods such as capital or bond fund programs, or through easements and deed restrictions.
8. **Septic System Upgrades/Maintenance Program:** Septic systems are very common sources of contamination in groundwater. If the microbial contamination control area contains high-density septic system areas (more than one septic system per acre), it would be prudent to initiate an effort to upgrade these systems, or at least implement a voluntary or mandatory program for maintenance (e.g., septic systems should be pumped out every 2-3 years for proper functioning). The community may also consider implementing a septic tank cleaner ban or prohibition within the microbial contamination control area. Most septic system cleaners contain solvents which not only contaminate groundwater as chemicals but also increase transportation of other pollutants through facilitating their release from solid state. Any such ban or prohibition is difficult to enforce, and would need to have an educational component associated with it. In fact, the community may need to count on voluntary compliance.
9. **Potential Source Restrictions:** The community may also want to consider establishing and implementing restrictions on the placement of some high-risk potential contaminant sources such as underground storage tanks, dry wells, sumps, injection wells, lagoons, biosolids spreading,, manure spreading and landfills within the microbial contamination control area.

Some of these microbial contamination control measures may be applied to the entire microbial contamination control area and others only to its specific zones of influence established in the process of the required delineation of the wellhead protection area. For example, different measures may need to be applied to the 50-day and 2-year time-of-travel (TOT) zones within the wellhead protection area.

5.3.2 Measures for commercial and industrial sources of contamination

The commercial and industrial facilities in the microbial contamination control area are generally the most highly regulated of any land uses. However, even facilities that are required to have permits/approvals for building, material storage or waste discharge cannot be assumed to pose no risks to groundwater. In many such cases there is much that can be done in prevention of groundwater contamination, and this is where the community's efforts in working with the commercial and industrial facilities should be focussed.

In dealing with owners of commercial and industrial sources of contamination, the municipality may consider the following actions or measures:

- encourage participation in pollution prevention and waste reduction programs that may be offered by the federal and provincial governments.
- distribute information on general best management practices related to groundwater,
- protection applicable to the majority of the potential commercial/industrial sources within the microbial contamination control area,
- send individual letters with information on resources available to identify best management practices for specific facilities,
- host informative meetings with the leaders of the local business community to raise awareness of the need for groundwater protection,
- establish a recognition program for businesses that take voluntary actions to protect groundwater,

- facilitate employee training workshops to raise awareness of groundwater and potential impacts from mismanagement of hazardous wastes, and
- introduce basic training in prevention of groundwater contamination as part of grade school curricula

Apart from these actions geared towards encouraging voluntary implementation of groundwater protection measures, where applicable, the municipality should review and/or inspect all locally regulated/permitted facilities for adequacy and compliance with permit requirements. Such inspections may also serve to verify that any provincially approved/permitted operations associated with those facilities (e.g., wastewater treatment and disposal facilities) have valid approvals or permits.

5.3.3 Measures for agricultural and rural sources of contamination

The overall objectives that agricultural lands within the microbial contamination control area would be expected to meet are:

- proper handling and application of agricultural chemicals, and other controlled substances;
- proper manure storage and spreading,
- proper biosolids storage and spreading
- proper siting, installation, and maintenance of septic systems, wells, storage tanks, wastewater lagoons, and solid waste sites;
- proper management of irrigation and wastewater disposal; and
- proper siting and management of dairies and feedlots facilities.

The uniqueness of the approach that needs to be taken in the development of a management plan for addressing potential sources of contamination related to agricultural lands and activities lies in two facts. One is that during the inventory of the microbial contamination control area, it would not be possible to assess specific activities or practices on each farm (only the most obvious and visible types of agricultural activity would be identified in the inventory). The other fact is that implementation of any improvements to the existing agricultural activities may only be accomplished through voluntary efforts of the farmer because, in Ontario, any management alternative that would seek to regulate farming practices may only be developed and implemented by the Ontario Ministry of Agriculture and Food. This situation is changing with the introduction of the Nutrient Management Act. The MOE regulates the spreading of non-farm biosolids through application of Part V of the EPA.

For these reasons, the development of any microbial contamination control measures related to agricultural activities must include two main steps:

- an on-farm assessment to identify those sources that pose the most significant risks to the groundwater; and
- identification and selection of the most appropriate management tools or measures to apply to the potential sources of contamination with the participation of the individual farmers and taking into account site-specific conditions.

Also, prior to undertaking any on-farm assessment, the municipality should verify existence of any OMAF developed or endorsed best management practices (BMPs) applicable to the types of agricultural activities in the microbial contamination control area, and refer to those BMPs both in the process of on-farm assessment and in the development of measures intended for implementation.

5.3.4 Measures for residential and municipal sources of contamination

Residential areas are not typically thought of as being potential sources of groundwater contamination, however, it is now well recognized that these areas can be significant sources of groundwater pollutants.

Municipal contaminant sources are grouped with residential because many of contamination sources associated with municipal activities are found in the same areas as the residential land uses.

Although the tools for managing many of the potential sources of the "municipal" type may be the same as for those of the "commercial/industrial" type, usually, a different approach in managing these sources needs to be taken as these sources are often associated with publicly-owned facilities. Reference to the suggested tools for the "commercial/industrial" sources should be made especially to address sources such as sewage treatment and disposal facilities and waste transfer stations.

For the identified contamination sources associated with facilities owned by the municipality responsible for the development of this microbial contamination control program, the approach is obvious; the municipality must identify the improvements it intends to undertake at those facilities in order to reduce potential for contamination of the groundwater.

Microbial contamination control measures specific to residential/municipal contamination sources, and not already addressed in the "general" or "commercial/industrial" categories of measures above, are those associated with urban runoff/storm water, waste disposal landfills and dumps.

In order to reduce potential for groundwater contamination that may be associated with urban runoff (storm water), the municipality should encourage the use of best management practices (BMPs) to improve the quality of storm water that my find its way into the groundwater aquifer, such as:

- use of Detention Ponds - earthen embankments or excavated ponds intended for the temporary detention of storm water to control peak runoff rates and for the settlement of particulate pollutants;
- use of Retention Ponds - earthen embankments or excavated ponds that usually contain a permanent pool intended for the retention of storm water runoff and for the settlement of particulate pollutants;
- use of Vegetated Swales - grassed water courses that retard or impound concentrated runoff to induce infiltration and decreased velocities;
- use of Vegetated Filter Strips - areas of vegetated cover through which runoff containing sediments and other pollutants must flow before leaving a site or entering a storm water management practice;
- use of Urban Forestry - protection of trees and forest land during the construction phase of development; planting of trees after the site has been cleared; or homeowner landscaping after the site has been fully developed;
- use of Sand Filters - self-contained bed of sand underlain with pipe that is designed to treat the first flush of storm water runoff, and may be enhanced by layers of peat, limestone and/or topsoil, and may be planted with grass.
- application of the Stormwater Management Manual (MOE)
- maintenance of trees and shrubs for a specified distance back from top of stream bank or ravine or bank of any other water body
- establishment of conservation easements (tax incentives) to retain rural streambanks, valleys and flood plains in forest cover with no agricultural intrusion (e.g., wandering livestock)

For areas where the municipality is the responsible authority, the municipality should identify the groundwater protection BMP's it intends to use.

For any waste disposal landfills or dumps operating within the microbial contamination control area, the municipality should verify that they valid provincial approval and that adequate groundwater monitoring is in place to prevent contamination.

5.4 Priority Microbial Contamination Control Measures

Table 5-2 included at the end of this document lists land use activities and sources that have the potential to increase microbial loadings in raw water pumped from the production wells. Land use activities and sources are grouped into high, moderate and low risk activities based on the amount of contamination generated and the potential for it to reach the water supply aquifer. Immediate and continuing action measures are listed separately for aquifer zones classified as high, moderate and low risk of being impacted by microbial contaminants released at ground surface.

5.5 Management of Activities that Might Affect *in situ* Filtration Effectiveness of the Aquifer

Table 5-3 included at the end of this document lists land use activities and sources that have the potential to increase particle counts in raw water pumped from the production wells. Immediate and continuing action measures are listed for high, moderate and low risk aquifer zones.

TABLE 5-2 PRIORITY MICROBIAL CONTAMINATION CONTROL MEASURES

LAND-USE ACTIVITIES & SOURCES*	Associated Land-Use Hazard	AQUIFER MICROBIAL RISK RANKING					
		High		Moderate		Low	
		Immediate Action Measure	Continuing Action Measure	Immediate Action Measure	Continuing Action Measure	Immediate Action Measure	Continuing Action Measure
COMMERCIAL/INDUSTRIAL - Large subsurface sewage disposal systems - Sewage lagoons - Wastewater treatment / disposal facilities - Land application of treated waste / sludge - Meat processing & rendering plants - Food processing/disposal lagoons - Dairy processing **AGRICULTURAL/RURAL** - Manure cesspools, agricultural liquid waste lagoons and drainage wells - Unsealed abandoned wells and test holes - Manure storage pits and spreading areas - Manure piles - Confined animal feeding operations (feedlots) - Dairy operations - Auction lots/boarding stables - Spray irrigation (of sewage effluent) - Land application of sewage and non-sewage biosolids - Storage facilities for biosolids **RESIDENTIAL/MUNICIPAL** - High density development on septics - Unsealed abandoned wells and test holes - Stormwater infiltration basins and galleries - Sewage treatment/disposal facilities - Land application of treated waste / sludge	**High**	Restrict/remove current or potential activities generating significant sources of microbial contaminants Abandonment of unsealed/unused wells and any other potential point contaminant source Use alternative technologies to improve effluent quality before discharge Modify existing works to accommodate treatment Site specific monitoring where applicable Proper abandonment of unsealed/unused wells and any other potential point source of contamination	Property Purchase/Donation Program Zoning and Other By-laws Groundwater Monitoring Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices	Restrict disposal of untreated liquid manure, sewage and/or liquid waste through lagoons, trenches and drainage wells Strict control through land acquisitions, zoning, bylaws, and/or easements Pollution prevention Implement site-specific monitoring programs where applicable	Public Education / Notification Sign Installation Water Conservation Program Public/Private Partnerships GW Monitoring Program Property Purchase / Donation Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices	General monitoring at wellhead Control measures via municipal acquisitions, zoning by-laws, and easements	Public Education / Notification Sign Installation Water Conservation Program Public/Private Partnerships Groundwater Monitoring Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices

COMMERCIAL/INDUSTRIAL - Cemeteries or graveyards - Animal burial grounds - Funeral, veterinary and taxidermy services - Stormwater runoff swales, ditches, ponds **AGRICULTURAL/RURAL** - Wildlife feeding and migration areas - Veterinary services - Aquaculture operations (fish farming) - Stormwater surface runoff swales, ditches, and ponds - Waste disposal landfills and dumps - Septic systems - Campgrounds and trailer parks **RESIDENTIAL/MUNICIPAL** - Stormwater runoff swales, ditches, ponds - Waste disposal landfills and dumps - Waste transfer and recycling stations - Septic systems, sewage lagoons - Campgrounds and trailer parks - Sewer lines	**Moderate**	Strict control through land acquisitions, zoning, bylaws, and/or easements Pollution prevention Site specific assessment and monitoring Site specific monitoring where applicable Priority maintenance of stormwater and sewer pipelines and other works	Public Education / Notification Water Conservation Program Public/Private Partnerships GW Monitoring Program Property Purchase / Donation Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices	Pollution prevention Modify/design stormwater treatment to discourage flow through least resistant contaminant pathway Implement site specific monitoring programs	Sign Installation Water Conservation Program Public/Private Partnerships GW Monitoring Program Septic Upgrades / Maintenance Program Potential Source Restrictions Follow Best Management Practices		Sign Installation Water Conservation Program Follow Best Management Practices
COMMERCIAL/INDUSTRIAL **AGRICULTURAL/RURAL** - Grazing lands - Ponds, creeks, streams - Rural homesteads **RESIDENTIAL/MUNICIPAL** - Low density privately serviced developments - Apartment and condominium buildings - Housing developments - Snow Dumps	**Low**	General monitoring at wellhead Land-use controls / restrictions Prohibit specified products within the time of travel zone	Water Conservation Program Septic Upgrades / Maintenance Program Follow Best Management Practices		Public Education / Notification Water Conservation Program Follow Best Management Practices	No special additional action required	No special additional action required

TABLE 5-3 MANAGEMENT OF ACTIVITIES THAT MIGHT AFFECT *IN SITU* FILTRATION EFFECTIVENESS OF THE AQUIFER

ACTIVITIES & SOURCES*	AQUIFER DISTURBANCE AS A POTENTIAL FOR AN INCREASE IN PARTICLE COUNT - RISK RANKING					
	High		Moderate		Low	
	Immediate Action Measure	Continuing Action Measure	Immediate Action Measure	Continuing Action Measure	Immediate Action Measure	Continuing Action Measure
Blasting Operations Drilling new wells Quarries Aggregate Extraction Pond Construction Utility Trenching Rupture of Stormwater pipe Highway and roadway construction	Restrict/remove activities with significant potential for increase of particle counts Use alternative technologies to limit stress on the hydrogeologic regime Modify existing works to accommodate monitoring /contingency measures Site specific monitoring where applicable Priority maintenance of stormwater and sewer pipelines and other works Modify/design stormwater treatment to discourage flow through least resistant contaminant pathway Pollution Prevention	Public/Private Partnerships Zoning and Other By-laws Groundwater Monitoring Program Property Purchase/Donation Program Potential Land-Use Restrictions Follow Best Management Practices Regular Maintenance Program	Strict control through land acquisitions, zoning, bylaws, and/or easements Pollution prevention Implement site-specific monitoring programs where applicable Priority maintenance of stormwater and sewer pipelines and other works Modify/design stormwater treatment to discourage flow through least resistant contaminant pathway	Public Education / Notification Sign Installation Water Conservation Program Public/Private Partnerships GW Monitoring Program Property Purchase / Donation Program Regular Maintenance Program Potential Land-Use Restrictions Follow Best Management Practices	Priority maintenance of stormwater and sewer pipelines and other works Control measures via municipal acquisitions, zoning by-laws, and easements Modify/design stormwater treatment to discourage flow through least resistant contaminant pathway	Public Education / Notification Sign Installation Water Conservation Program Public/Private Partnerships Groundwater Monitoring Program Regular Maintenance Program Potential Land-Use Restrictions Follow Best Management Practices

Appendix A

GSC Geomaterial Protocol

The GSC Geomaterial Protocol provides the basis for a standardized approach to material descriptions for all borehole information used in a groundwater study. The protocol is best applied at the outset of a project and directly to borehole data sets received from various agencies. The coding routine is best used within a relational database structure (e.g. SiteFX software). Use of a relational database facilitates the standardizing of a large number of boreholes and information such as the 212 fields in the MOE water well records.

The coding protocol was developed by geologists who re-coded material descriptions found in provincial water well records. The records allow for the use of three fields for drillers to enter material descriptions; however, only one field was used in most records. To partly compensate for this problem, the geologists linked re-coding rules to the many thousands of field sites they observed during geological mapping studies. In 1998, the GSC published the results of their extensive testing program as part of database developed through the Oak Ridges Moraine Hydrogeology Project. One conclusion of the re-coding and field testing was that the "clay" descriptions are over represented compared to their occurrence in the field, by a factor of 10. This is a significant finding because "clay" material is often used as a key factor in determining groundwater vulnerability.

A description of the geomaterial protocol is found in the following reference:

Standardization and assessment of geological descriptions from water well records: Greater Toronto and Oak Ridges Moraine Areas, southern Ontario. Russell, H. A. J., Brennand, T. A., Logan, C., and Sharpe, D. R., 1998, Current Research 1998-E: Ottawa, Geological Survey of Canada, p. 89-102.

The Ontario Ministries of the Environment, Natural Resources, Mines and Northern Development contribution have been acknowledged in the reference. The reference is available through the internet site at: http://sts.gsc.nrcan.gc.ca/orm/acrobat_data.asp.

The abstract and tables 1, 3 4, and 5 are presented here, followed by the suggested method for documenting the Metadata for the GSC Geomaterial Protocol.

Abstract

Archival drilling records from water wells, geotechnical, mineral exploration, and hydrogeologic studies provide subsurface information for regional geologic and hydrogeologic investigations. This paper evaluates methods by which water well material descriptions may be standardized. In Ontario, material descriptions are reported in three attribute fields using 82 terms, thus theoretically permitting over 500,000 permutations. Materials descriptions are rationalized to 10 classes then reclassified according to two methods: (i) First-Attribute Method (FAM), and (ii) Rule-Based Method (RBM). The first-attribute method is presently applied by hydrogeologists in southern Ontario and uses only the first attribute field; it is a simple, effective method able to broadly delimit aquifers and non-aquifers. The rule-based method applies conditional rules developed from regional geologic models. This method is more geologically accurate, and is recommended where water well data are to be integrated into geologic and hydrogeologic investigations. Successful applications are summarized and general recommendations made.

Table 3 - Rationalized Descriptors for MOE WWIS. (%- usage in all 3 materials data fields)		
Rationalized Descriptor	**MOE Dataset Descriptor**	
1 bedrock (0.1%)	18 sandstone	40 flint
	20 quartzite	41 gneiss
	21 granite	42 greywacke
	22 greenstone	43 gypsum
	26 rock (bedrock)	44 iron fm.
	36 basalt	45 marble
	37 chert	46 quartz
	38 conglomerate	47 schist
	39 feldspar	48 soapstone
1.1 limestone (0.8%)	15 limestone	16 dolostone
1.2 shale (0.9%)	17 shale	82 shaly
	19 slate	
2 gravel (9.7%)	11 gravel	31 coarse gravel
	12 stones	32 pea gravel
	13 boulders	72 gravelly
	29 fine gravel	87 stoney
	30 medium gravel	
3 sand (12.3%)	7 quicksand	10 coarse sand
	8 fine sand	28 sand
	9 medium sand	81 sandy
4 silt (1.5%)	6 silt	84 silty
5 clay (16.1%)	5 clay	61 clayey
6 diamicton (0.5%)	14 hardpan	34 till
7 organic (0.1%)	3 muck	33 marl
	4 peat	35 wood frags.
8 fill (3.7%)	1 fill	25 overburden
	2 topsoil	
9 previously dug (0.7%)	0 unknown	24 previously drilled
	23 previously bored	
99 null (53.6%)	27 -	

Appendix B

Generic Representative Permeability (K-Factor) Table

Geomaterial	Representative K-Factor (dimensionless)*	K-Value (m/s) @75% range**	Highest K-Value (m/s)
gravel weathered dolomite/limestone karst permeable basalt	1	1.00E-01 1.00E-06 1.00E-03 1.00E-03	0.1
sand	2	0.01	1.00E-02
peat (organics) silty sand weathered clay (<5m below surface) shrinking/fractured & aggregated clay fractured igneous metamorphic rock weathered shale	3	1.00E-03 1.00E-04 1.00E-04*** 1.00E-04*** 1.00E-05 1.00E-05***	1.00E-03
Silt loess limestone/dolomite	4	1.00E-06 1.00E-06 1.00E-06	1.00E-06
weathered/fractured till diamicton (sandy, silty) diamicton (silty, clayey) sandstone	5	1.00E-07 1.00E-07*** 1.00E-08*** 1.00E-07	0
clay till clay (unweathered marine)	8	1.00E-09*** 1.00E-10	0
unfractured igneous and metamorphic rock	9	1.0000000e-13	0

* Representative K-factors are relative numbers and do not correspond directly to the exponent or index of the observed K-Values for the geomaterial in the group.

** Correspondence with descriptors of observed K-Values in Freeze & Cherry 1979. Prentice-Hall. Derived using the length of the line to determine the 75% value and rounding to the highest K-Value.

*** Estimated value based on field studies in Ontario

NOTE: When actual study area data are available, this chart should be used to assign the corresponding K-Values for locally defined geomaterial (e.g., Mayhill Till) and then apply the appropriate Representative K-factor in the calculation of the index of the groundwater intrinsic susceptibility to contamination

Ontario

Ministry of the
Environment

GUIDANCE DOCUMENT

DEVELOPMENT OF MICROBIAL CONTAMINATION CONTROL PLANS

(*Interim Wellhead Protection Measures Plan*)

FOR MUNICIPAL GROUNDWATER SUPPLY WELLS UNDER DIRECT INFLUENCE OF SURFACE WATER WITH EFFECTIVE IN-SITU FILTRATION

Date: January 2004

GUIDANCE DOCUMENT
Development of Microbial Contamination Control Plans
(Interim Wellhead Protection Measures Plan)
for
Municipal Groundwater Supply Wells under Direct Influence of Surface Water with Effective in-situ Filtration

January 2004

I. PURPOSE

The purpose of this Guidance Document is to help municipalities develop plans for implementation of measures to protect the sources of their groundwater supplies from microbial contamination. Development and implementation of microbial contamination control plans, subject to approval by the Ministry of the Environment, is required for municipal drinking-water systems using groundwater under the direct influence of surface water (GUDI) with effective *in situ* filtration where the municipality chooses not to provide chemically assisted filtration, or approved equivalent treatment, ahead of disinfection.

The focus of microbial contamination control plans is the implementation of measures to minimize aquifer disturbance and microbial contaminant loadings to the aquifer in close proximity to GUDI wells relying on *in situ* filtration for the removal of suspended particulate matter. Particulate matter could harbour large numbers of microbes and interfere with the disinfection process.

Since this particulate matter removal through *in situ* filtration would otherwise be achieved through an engineered chemically assisted filtration process, the *in situ* filtration is considered an integral part of the water treatment process. For the same reason, the requirement for the implementation of measures intended to preserve integrity of the aquifer's overburden in the vicinity of the wellhead and minimize microbial contaminant loading to the aquifer are considered to be water treatment related requirements.

If required, these wellhead protection microbial contamination control measures, may become the first step in the implementation of a long-term source water protection plan. The Ministry of the Environment is currently considering a province wide program of source water protection. At some point in time, all municipalities may be required to develop and implement comprehensive wellhead protection plans addressing all potential sources of contamination (not only microbial contamination). These comprehensive plans would extend beyond the immediate zone of influence on the wellheads to which these wellhead protection microbial contamination control measures apply. For this reason, these microbial contamination control measures have been referred to as interim wellhead protection measures.

This document must be used in conjunction with ***"Terms of Reference for Hydrogeological Study to Examine Groundwater Sources Potentially under the Direct Influence of Surface Water"*** ("GUDI Terms of Reference"), and ***"Protocol for Delineation of Wellhead Protection Areas For Municipal Groundwater Supply Wells under Direct Influence of Surface Water"*** ("Delineation Protocol"). These documents contain direction and details with regard to steps that need to be followed before preparation of microbial protection plans.

II. APPLICABILITY

This Guidance Document specifically applies to municipal groundwater supply systems where the delineation of wellhead protection areas and a proposal for implementation of wellhead protection measures is a requirement of a consolidated Certificate of Approval for the water works issued by the Ministry on the basis of the review of the Engineer's Report submitted in accordance with the Drinking Water Protection Regulation (O.Reg. 459/00).

Under the consolidated Certificate of Approval process, hydrogeological studies were required for all municipal wells which had been determined to be potentially under the direct influence of surface water. These studies had to be conducted in accordance with the Ministry document "***Terms of Reference for Hydrogeological Study to Examine Groundwater Sources Potentially under the Direct Influence of Surface Water***" (GUDI Terms of Reference).

As explained in the GUDI Terms of Reference, where such a hydrogeological study has concluded that the groundwater source is under the direct influence of surface waters and that the aquifer is providing effective *in situ* filtration, the owner is required to:

- provide chemically assisted filtration (or equivalent) followed by disinfection; or

- (1) provide enhanced disinfection, (2) delineate wellhead protection areas in accordance with the Ministry document ***"Protocol for Delineation of Wellhead Protection Areas for Municipal Groundwater Supply Wells under Direct Influence of Surface Water"***, and (3) develop and submit for Ministry approval a proposal for implementation of adequate wellhead protection measures to ensure continued effectiveness of the *in situ* filtration processes.

A microbial contamination control plan developed by a municipality in accordance with this Guidance Document and submitted to the Ministry will satisfy conditions of a Certificate of Approval that requires submission of a plan for implementation of wellhead protection measures related to a GUDI system with adequate *in situ* filtration. Based on this submission, the Certificate of Approval would be amended to include requirements regarding implementation of the plan.

Unless specifically required otherwise by conditions of a future Certificate of Approval, this Guidance Document will also apply to a proposal for implementation of ~~an~~ *in situ* filtration related wellhead protection measures that may be required to be submitted under conditions of a subsequently issued Certificate of Approval for a drinking-water system under the new Safe Drinking Water Act and in accordance with the new Drinking-Water Systems Regulation (O.Reg 170/03) under the Safe Drinking Water Act.

III. DEVELOPMENT OF A MICROBIAL CONTAMINATION CONTROL PLAN

In accordance with the "***Terms of Reference for Hydrogeological Study to Examine Groundwater Sources Potentially under the Direct Influence of Surface Water***" ("GUDI Terms of Reference"), in order for a well to be characterized as having "effective *in situ* filtration", the following conditions must be met:

a) Particle count data must show that the water consistently contains significantly less than 100 particles per mL in the size range 10 microns and greater in size. Particle counts must remain constantly low during storm, season or other regular environmental changes. This is required to ensure that embedded microbes are not shielded from effective UV or chlorine disinfection.

b) The raw water does not contain significant microbial loadings. This is required to ensure that the disinfection processes are not overwhelmed by microbial loadings.

The microbial contamination control plan must, therefore, address both particle counts and microbial loadings. To do this, the plan must:

1. Delineate microbial risk management zones.
2. Inventory and rank the risk of existing and potential activities that might affect the *in situ* filtration capability of the aquifer.
3. Inventory and rank the risk of existing and potential sources of microbial contamination.
4. Identify measures to protect well(s) from microbial contamination and to protect the *in situ* filtration capability of the aquifer.
5. Develop appropriate monitoring and contingency plans.
6. Establish a schedule for implementation of the microbial contamination control measures.

The following sections of this part of the Guidance Document provide detailed recommendations regarding the above list of required elements/steps of a microbial contamination control plan intended to be submitted to the Ministry in support of a proposal not to include a chemically assisted filtration step in the water treatment system using groundwater under direct influence of surface water.

For additional information and suggestions, the municipality developing such a microbial contamination control plan may also refer to the **"Reference Document - Model Microbial Contamination Plan for Municipal Groundwater Supply Wells under Direct Influence of Surface Water with Effective *in situ* Filtration"**.

1. Delineation of Microbial Risk Management Zones

Time of travel zones must be delineated for each municipal well and well-field to which the requirement applies. The delineation must be completed in accordance with the Ministry document ***"Protocol for Delineation of Wellhead Protection Areas For Municipal Groundwater Supply Wells under Direct Influence of Surface Water"*** ("Delineation Protocol").

Based on the explanations provided in the delineation protocol, for the purpose of developing the microbial contamination control plan, the focus should be on the identifying the following two saturated horizontal time of travel (TOT) zones:
1) 0 to 50 days
2) 50 days to 2 years

In accordance with the Delineation Protocol, three-dimensional, steady-state computer models (such as MODFLOW) should be used to delineate capture zones unless site-specific conditions suggest that other methods described in the Delineation Protocol are more appropriate. For example, where limited hydrogeological data are available and the well is in a remote sand plain, simpler methods utilizing conservative assumptions may be adequate.

In assessing potential microbial risks, consideration can be given to groundwater intrinsic susceptibility (GwIS). Intrinsic susceptibility is the time it takes for water to move from ground surface down into the upper water bearing zone supplying the well. For example, 20 metres of silt over a confined aquifer would have a low intrinsic susceptibility whereas 10 metres of clean coarse sand or fractured rock would have a high susceptibility to contamination because it provides faster travel times and less retardation. Key attributes are the depth to upper water bearing zone and the conductivity of overlying geologic material. Where there is uncertainty regarding aquifer depth, the water table should be used.

2. Protection of *In Situ* Filtration Effectiveness of the Aquifer

To ensure the continued effectiveness of disinfection processes, particle counts must remain constantly low. Land use activities in the vicinity of a communal well whose water treatment process relies on the presence of effective in-situ filtration instead of a chemically assisted filtration (or equivalent)ahead of disinfection must, therefore, be controlled to ensure that the aquifer is not disturbed. Any nearby land uses causing significant ground vibration or which involve subsurface excavation, drilling or boring could potentially disturb the integrity of the aquifer and result in elevated particle counts in the well water.

3. Assessment of Microbial Contamination Risks

Contaminant inventories typically identify locations where activities are releasing or have the potential to release one or more contaminants into groundwater at a concentration of concern. Since this microbial contamination control plan is intended to ensure effective wellhead protection against potentially pathogenic microbial contaminants, it is appropriate to focus this contaminant inventory on the known and potential sources of pathogenic microbial contamination only (pathogenic viruses, bacteria, and protozoa).

In general, more stringent risk management measures such as property acquisition, planning and regulatory controls and verification through groundwater monitoring programs are used within the 50-day TOT zone.

3.1 Inventory of Microbial Contaminant Sources

3.1.1 Scope of the inventory: Since the risk of pathogenic microbial contamination of wells is normally limited to contaminant sources located in proximity, it is acceptable to focus this inventory on sources of pathogenic microbial contamination located within the 0 to 2-year TOT zones. However, high risk sources of microbial contaminants (such as communal sewage lagoons and livestock yards) should be identified even if they are beyond the 2-year TOT. All zones up to 25 year TOT are supposed to have been delineated in accordance with the Delineation Protocol.

3.1.2 Sources of potential microbial contamination: The inventory must include all sites/locations where there are existing and potential sources of pathogenic microbial contamination:

- Commercial/Industrial sources include activities such as graveyards, meat processing/packing plants, wastewater treatment/disposal facilities, areas of land application of wastewater treatment effluent/sludge etc.
- Agricultural/Rural sources include activities such as confined animal feeding operations, manure storage pits/liquid waste lagoons, manure spreading areas, sewage biosolids and other biosolids spreading areas, veterinary services, grazing lands, wildlife feeding/migration areas, aquaculture operations (fish farming), rural homesteads, campgrounds and trailer parks, stormwater surface runoff swales, ditches and ponds, waste disposal landfills and dumps etc.
- Residential/Municipal sources include housing developments, apartment/condominium buildings, campgrounds and trailer parks, sewage treatment/disposal facilities, septic systems and sewer lines, stormwater infiltration basins, wells and galleries, waste disposal landfills and dumps, unsealed abandoned wells and test holes etc.

3.1.3 Contents of the inventory of contamination sources: Information on each of the identified existing and potential sources of contamination should be compiled in a list including:

a) description of the contamination source:

- source name (if applicable), and name of owner/operator
- indication if it is an existing or potential source
- type of the source (see Section 3.1.2)
- approximate areal size of the source
- permanent/intermittent

b) location of the source:

- address (if applicable)
- geo-reference information based on NAD83 (North American Datum 1983). Field-based GPS coordinates are mandatory for major potential contaminant sources in high risk areas; desktop analysis may be sufficient in low risk areas.
- approximate saturated horizontal TOT to the well/well field
- linear distance to the well/well field
- current municipal land use zoning and land use designation for the location
- current land use
- source risk rank or category (see below)

In addition to the inventory list, all identified existing and potential sources of microbial contamination must be accurately plotted and identified (existing/potential, name and type) on a copy of the to-scale TOT delineation map prepared in accordance with the Delineation Protocol. This copy of the TOT delineation map must also identify the current municipal zoning and land use designations.

3.1.4 Risk Ranking/Categorization of the Contaminant Sources: Any identified source of microbial contamination within the delineated time of travel zones can pose a risk of contamination and possible loss of the water supply. Due to limited resources, however, it may be necessary for the municipality to focus efforts on the sources which pose the most significant risks.

In order to establish priorities for the plan of implementation of microbial contamination control measures, it is necessary to evaluate the relative degree of risk that the individual contamination sources identified in the inventory pose to the water supply. For this purpose, each identified contamination source must be ranked based on the relative degree of susceptibility of the water supply to contamination from the particular contamination source, and the likelihood that the source will release contaminants.

In such a risk ranking/categorisation, the individual source's risk (R) rank/category would be the product of the water supply's degree of susceptibility (S) to contamination from the source and the contamination source's degree of hazard (H), that is, the likelihood that the source will release contaminants. This relationship can be stated as an equation: SxH=R.

The likelihood that the potential contamination source will release significant amount of contaminants (the source's degree of hazard [H]), e.g., low, moderate or high, will depend on factors such as the amounts of contaminants generated by the source (size of the source), and the existence and the level of any groundwater protection measures such as the use of best management practices (BMPs) and monitoring of groundwater quality down-gradient from the source.

4. Microbial Contamination Control Measures

Microbial Contamination Control Measures must include the following components:
1) identification of potential risks,
2) recommendations to reduce/manage the risk of contaminant release to groundwater, and
3) recommendations for control of new development and specific activities within the area.

Although some of the microbial contamination management tools identified here refer to regulatory programs, it is generally accepted that groundwater protection within specific time of travel zones of the microbial contamination control areas can be accomplished most effectively and at the least cost by developing partnerships with local business, industry and the agricultural community, and focussing on educational/training and pollution prevention or best management practices concepts.

Since groundwater quality can be affected by a wide variety of human activities and sources, a comprehensive groundwater protection control program would incorporate various types of measures. These various microbial contamination control measures may be categorized into three general areas:
- pollution prevention/best management practices (BMPs),
- regulatory permitting/environmental assessment, and
- land use controls or restrictions.

4.1 Pollution Prevention/Best Management Practices: Pollution prevention is the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. The term Best Management Practices (BMPs) is generally used to describe operational practices, such as good housekeeping and spill prevention, or source control practices, such as designing a storm water system that prevents rapid infiltration in the water supply aquifer. Encouragement of implementation of BMPs through free technical assistance or training may be one very effective tool for local governments to use in reducing the risks of groundwater contamination in designated time of travel zones. Efforts at the local level to recognize businesses that employ environmentally sound practices and encourage consumers to support those businesses contributes significantly to the success of this program.

4.2 Regulatory Permitting/Approvals and Environmental Assessment: These measures are implemented through provincial laws, local by-laws and planning requirements. Technical standards are generally used to establish and ensure compliance with permitted discharges. These laws and requirements can affect the siting, design, construction, operation, and closure of facilities such as buildings, above and underground storage tanks, treatment plants, landfills, and transportation corridors.

In Ontario these laws include the Environmental Assessment Act, Environmental Protection Act, Ontario Water Resources Act, including the Drinking Water Protection Regulation (O.Reg 459/00) and the Water Wells Regulation (O.Reg 903 amended to O.Reg 128/03), and the Safe Drinking Water Act, including the Drinking-Water Systems Regulation (O.Reg 170/03) administered by the Province, as well as the Drainage Act and the Building Code (including the Plumbing Code) administered by the local governments.

One of the tools available to local government in managing potential contamination sources within specific time of travel zones of the microbial contamination control areas is the review and/or inspection of locally regulated/permitted facilities for adequacy and compliance with permit requirements. Such inspections may also serve to verify that any provincially approved/permitted operations associated with those facilities have valid approvals or permits.

4.3 Land Use Controls or Restrictions: An opportunity for promotion of microbial contamination prevention plans is through a municipality's Official Plan and Zoning By-laws. This approach notifies everyone with an interest in specific land uses and land use proposals that there are ground water contamination concerns. In addition, an Official Plan can contain schedules which map out well head protection zones for lands currently developed and for

those which have not yet been developed. These measures are most effective where an area has not been extensively developed. Land use controls can be extremely effective in reducing the risk of groundwater contamination by restricting high-risk activities or limiting development densities in sensitive areas. In some cases, it may be feasible to introduce by-laws to restrict or prohibit specified activities within already developed time of travel zones.

The efforts to consider and select microbial contamination control measures for various sources of contamination and land uses should start with general management tools such as public education, public/private partnerships, zoning by-laws, contaminant use restrictions and follow with tools specific to the type of contamination source, i.e., residential, commercial, and agricultural.

5. Monitoring Plans and Contingency Measures

Depending on the intrinsic susceptibility of the aquifer to contamination and the nature of nearby microbial contamination risks, it may be necessary to develop a sentinel monitoring program to ensure that public health and safety is effectively protected. This monitoring program would involve regular monitoring in observation wells established between municipal production well(s) and potential sources of microbial contamination and areas of potential aquifer disturbance.

6. Schedule for Implementation of Microbial Contamination Control Measures

The establishment of a proposed implementation schedule is the last step in the development of a microbial contamination control plan ("proposed wellhead protection measures").

Timely implementation of appropriate microbial contamination control measures for these drinking-water systems is crucial in ensuring continued effectiveness of the *in situ* filtration processes and the overall safety of the supplied drinking water. Therefore, in order for the Microbial Contamination Control Plan (and the proposal not to provide chemically assisted filtration) to be acceptable to the Ministry (Director), the proposed implementation schedule must show that the municipality intends to implement the necessary measures as quickly as reasonably possible.

IV SUBMISSION OF A REPORT TO MOE

Where the microbial contamination control plan has been developed in support of a request for MOE approval not to include chemically assisted filtration step in the water treatment process, the municipality's submission to the MOE must include the following documentation:

- the contamination source inventory list prepared in accordance with this Guidance Document, including the source ranking/categorization,
- a copy of the to-scale WHPA delineation map prepared in accordance with the Delineation Protocol with all existing and potential sources of microbial contamination identified in the inventory list accurately plotted and identified (existing/potential, name and type of source),
- a detailed description of all microbial contamination control measures intended to be taken with references to the specific existing an potential contamination sources identified in the inventory, and
- a proposed schedule for the implementation of the proposed microbial contamination control measures.